Canada
Department of Agriculture
Experimental Farms Service

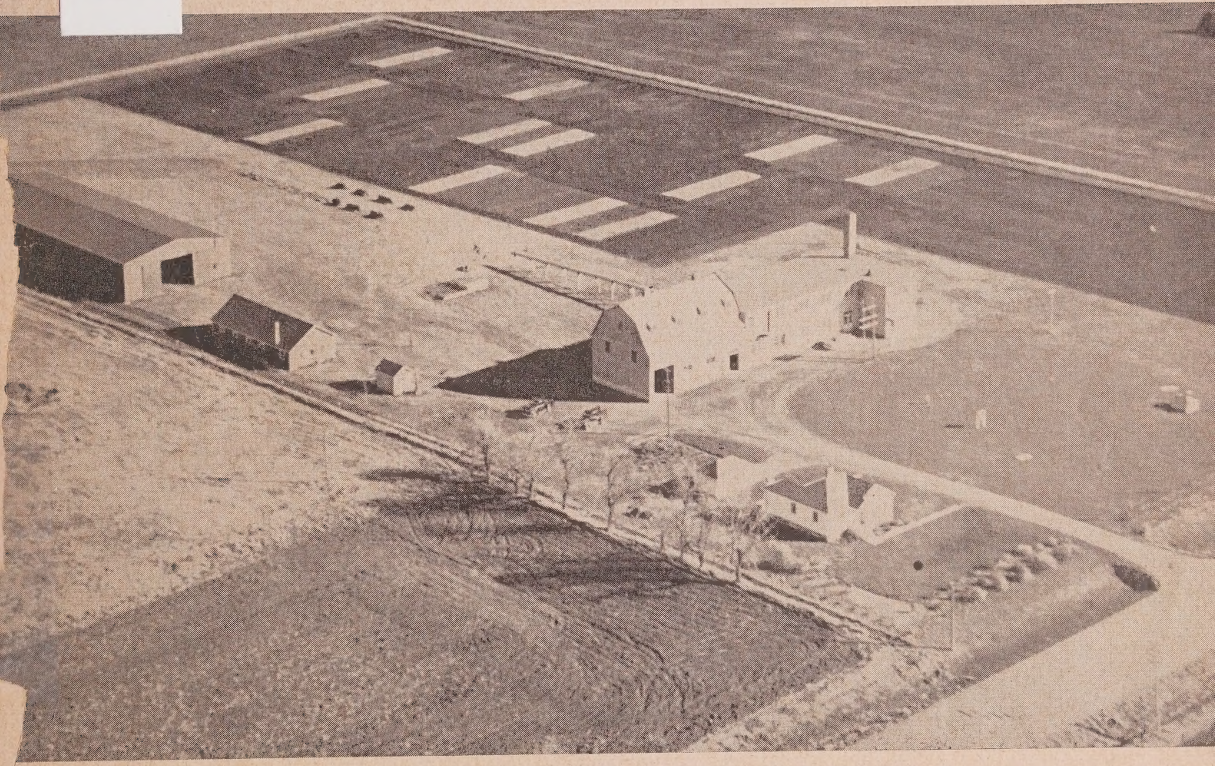
Pilot Flax Mill

Portage la Prairie, Manitoba

E. M. MacKey, B.S.A., Officer-in-Charge

SUMMARY PROGRESS REPORT

1944-1955



Aerial view of Pilot Flax Mill, Portage la Prairie, Manitoba

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Technical Personnel

FIBER DIVISION, CENTRAL EXPERIMENTAL FARM,
OTTAWA, ONTARIO

R. J. Hutchinson*.......................................Chief, Fiber Division
L. A. Cabana, B.A., L.S.A...............................Assistant

PILOT FLAX MILL,
PORTAGE LA PRAIRIE, MANITOBA.

E. M. MacKey, B.S.A.....................................Officer-in-Charge
W. O. Chubb, B.Sc., D.Sc................................Chemist
C. H. Waldon..Technician

*Deceased 1953

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PILOT FLAX MILL

Portage la Prairie, Man.

Summary Progress Report

1944-1955

The Pilot Flax Mill at Portage la Prairie, Manitoba, was established in 1944 under the supervision of the Fiber Division, Central Experimental Farm, Ottawa. In 1953, after the death of Mr. R. J. Hutchinson, Chief, the Fiber Division was merged with the Field Husbandry, Soils and Agricultural Engineering Division.

Owing to the post-war decline in the demand for fiber flax, work on this crop was curtailed in 1955 at the Pilot Flax Mill and investigations commenced on other special crops. Consequently the name of the unit was changed from Pilot Flax Mill to Special Crops Substation. Under this new name it became associated with the Experimental Farm at Brandon, Manitoba.

This report covers the 12-year period (1944-55) of fiber flax investigations conducted at the Pilot Flax Mill. Some testing work with flax is to continue and the findings will be published, together with those from other special crops, in future reports from the Special Crops Substation. The breeding work with new fiber flax varieties, which is conducted by the Cereal Crops Division at Ottawa, will continue.

The former Flax Division at Ottawa conducted tests of new varieties of flax to determine their adaptability to different regions, and to compare flax production with other farm enterprises. The work of the Pilot Flax Mill at Portage la Prairie constituted one part of this program. The Mill, located on 10 acres of land, was equipped for experimental and investigational work on the utilization of linseed flax straw and fiber flax, both commercially and on a laboratory scale.

In addition to the 10 acres of land at the Pilot Flax Mill site, 47 acres of land directly across the road from the Mill were secured in 1948 under the Veterans Land Act. The field was fenced and divided into blocks of approximately 9 acres each. A five-year rotation of wheat, experimental plots, wheat (seeded down), hay, and summerfallow was set up in 1949 and proved very satisfactory. The weed population was greatly reduced and the physical condition of the soil improved.

The primary functions of the Pilot Flax Mill were:

(1) To conduct investigations on the industrial utilization of linseed flax straw produced in the Prairie Provinces with the object of increasing the revenue to prairie farmers from flax grown as an oil-seed crop.

(2) To conduct experiments on the production and processing of fiber flax, partly as a check on the work being done on linseed flax, and partly to determine to what extent and in what districts fiber flax can be economically produced in the Prairie Provinces.

The purpose of this progress report is to record and to discuss experimental results obtained in the growing and processing of flax at Portage la Prairie during the years 1944 to 1955, inclusive. Reference is also made to flax investigations conducted elsewhere on Experimental Farms and to the co-operation of officers of Science Service of the Department of Agriculture, as well as provincial agencies.

TABLE 1

ACREAGE, PRODUCTION, AND VALUE OF THE FIBER FLAX CROP IN CANADA, 1940 TO 1955, INCLUSIVE

Year	Area	Seed	Fiber	Upholstering tow	Total value
	(acres)	(bushels)	(pounds)	(tons)	($)
1940	20,275	79,300	3,965,000	1,027	2,008,325
1941	43,645	130,935	12,394,500	725	3,957,992
1942	47,471	195,915	17,452,000	1,076	4,698,612
1943	35,000	157,957	10,140,000	815	3,047,128
1944	39,102	122,487	5,768,000	1,015	2,109,298
1945	21,557	68,747	4,976,000	650	1,805,000
1946	15,862	81,000	1,786,000	1,000	917,000
1947	11,103	50,000	1,852,000	2,000	882,000
1948	14,229	50,000	3,700,000	600	1,366,000
1949	7,534	38,851	1,948,000	750	656,586
1950	4,581	27,486	1,519,628	950	503,317
1951	7,623	39,282	2,594,614	1,153	758,978
1952	7,920	47,520	1,704,117	1,500	470,797
1953	3,875	19,375	620,000	500	95,900
1954	1,435	10,000	—	250	47,500
1955	3,014	9,000	—	200	41,000
Total	284,226	1,127,855	70,419,859	14,211	23,365,433
Average 16 years	17,764	70,490	4,401,241	888	1,460,339

TABLE 2

ACREAGES OF FIBER FLAX BY PROVINCES
1940 TO 1955, INCLUSIVE

Year	Quebec	Ontario	Manitoba	Alberta	British Columbia	Total
1940	11,478	8,347	350	100	—	20,275
1941	27,786	13,394	2,230	100	135	43,645
1942	28,787	17,401	1,019	157	107	47,471
1943	21,785	11,575	500	140	1,000	35,000
1944	28,340	9,950	200	—	612	39,102
1945	15,372	5,562	286	107	230	21,557
1946	10,755	4,572	100	133	302	15,862
1947	5,708	4,658	100	250	387	11,103
1948	10,969	2,787	123	—	350	14,229
1949	4,840	2,607	52	—	35	7,534
1950	3,265	1,304	12	—	—	4,581
1951	5,562	2,049	12	—	—	7,623
1952	4,465	3,455	12	—	—	7,932
1953	2,860	991	12	24	—	3,887
1954	1,191	232	12	12	—	1,447
1955	2,535	455	12	24	—	3,026
Average 16 years	11,606	5,584	315	66	198	17,768

TABLE 3

PRICE RANGES OF FIBER FLAX LINE, TOW, AND SEED, FOR SELECTED PERIODS FROM 1915 TO 1955

Period	Line per lb.	Tow per lb.	Seed (Certified) per bushel
1915 to 1921	$0.45 to 1.00	$0.23 to 0.30	$3.00 to 8.00
1921 to 1938	0.17 to 0.25	0.07 to 0.10	2.75 to 6.00
1939 to 1947	0.35 to 0.55	0.14 to 0.22	5.00 to 8.50
1948 to 1950	0.26 to 0.35	0.10 to 0.17	5.00 to 7.50
1951	0.32 to 0.40	0.12 to 0.19	*
1952	0.23 to 0.32	0.07 to 0.14	*
1953	0.30 to 0.32	0.07 to 0.11	3.00 to 3.50
1954	0.27 to 0.29	0.07 to 0.11	3.00 to 3.50
1955	0.23 to 0.25	0.07 to 0.11	3.00 to 3.50

* Little if any seed was exported during this period. Seed not used for local seedings was disposed of at the price of linseed, which was $2.25 to $2.75 per bushel.

TABLE 4

Linseed Flax Acreage in Canada 1940 to 1955, inclusive

Year	Canada	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
1940	381,500	17,500	89,500	232,200	42,000	300
1941	996,500	11,800	170,000	681,000	131,000	2,700
1942	1,492,200	24,000	227,000	1,056,000	183,000	2,200
1943	2,947,000	24,000	284,000	2,084,000	550,000	5,400
1944	1,323,100	23,600	167,000	939,000	191,500	2,000
1945	1,059,200	23,200	260,000	655,000	119,000	2,000
1946	840,000	18,000	304,000	455,000	62,000	1,900
1947	1,573,700	56,200	556,000	700,000	257,000	4,500
1948	1,937,900	64,300	1,062,000	588,000	218,000	5,600
1949	320,000	16,500	134,000	132,000	37,500	—
1950	545,100	19,800	300,000	177,000	48,300	—
1951	1,151,800	65,800	655,000	296,000	135,000	—
1952	1,122,000	75,100	600,000	380,000	167,000	—
1953	926,000	41,000	420,000	342,000	164,000	10,400
1954	1,206,000	19,000	444,000	518,000	215,000	10,000
1955	1,988,400	16,400	531,000	1,180,000	248,000	13,000
Average (16 years)	1,238,150	32,263	387,719	650,950	173,019	
				(12-year average only)		5,000

Weather

In 1944 the spring was cold and wet and the early growth of the flax was considerably retarded, which resulted in a chlorotic condition in the plants. The total precipitation for the year was nearly 10 inches greater than the average for the 12-year period 1944 to 1955. Conditions in the spring of 1945 were similar and the flax was again retarded and chlorotic. In 1946 the weather was very dry at seeding time and the crop emerged and matured very unevenly. The season was good in 1947 with temperature and precipitation about normal. The first part of the season was good in 1948 but the remainder of the summer and the fall were very dry. Only 1.59 inches of rain fell from the beginning of August to the end of September. In 1949 rainfall was light in the early part of the season and an extremely hot, dry period occurred in early August when the flax was maturing.

In 1950 the first part of the season was very favorable but frequent heavy rain during the latter part of the season caused much lodging and second growth in the flax. This second growth prevented the flax straw from maturing before frost. The growing season was favorable in 1951. In the fall, however, the weather was colder than normal and rain so frequent that harvesting was much delayed. The precipitation in April and May 1952 was very low. This was accompanied by temperatures higher than normal and strong winds which dried the topsoil. As a result the crop sown in late April and early May germinated well but the crop sown in the second and third weeks of May germinated very slowly and unevenly. In this district, some soil erosion resulted from the dry, hot, windy weather. Rainfall was very unevenly distributed. Almost all the year's rainfall occurred in heavy downpours during June, July, and August. The total precipitation in 1952 was the lowest during the 12-year period and almost 6 inches lower than the average for the period.

In 1953 the spring rainfalls occurred at frequent intervals during seeding time, resulting in many seedings being delayed until the period between June 8 to 13. An open fall permitted most of the flax to mature (the frost-free period in 1953 was about 20 days longer than the 64-year average of 121 days) but some late-sown flax was damaged by frost. The season was good in 1954 and 1955 with temperature and precipitation about normal, although high rainfall in August and September of 1954 delayed ripening to some extent.

PRECIPITATION RECORDS

TABLE 5

(Records from the Department of Transport Climatological Stations at Portage la Prairie, Manitoba.)

Year	Monthly precipitation in inches (snowfall in inches x 0.1)												Total Annual		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Snowfall (inches x 0.1)	Rainfall	Precipitation
1944	0.74	0.39	1.74	0.36	2.77	9.13	1.98	6.80	1.72	1.03	0.96	0.46	3.86	24.22	28.08
1945	0.80	0.85	2.38	1.40	2.02	2.65	4.50	0.81	3.69	0.79	1.18	0.46	3.19	18.34	21.53
1946	0.27	0.28	2.13	0.27	0.35	2.56	3.48	1.43	2.81	1.68	0.67	0.33	2.11	14.14	16.25
1947	0.18	0.77	0.27	0.73	0.68	4.55	1.64	2.97	0.56	0.76	0.76	1.24	3.16	11.95	15.11
1948	0.54	0.52	0.46	1.41	1.91	3.30	3.42	0.97	0.62	0.37	0.88	1.00	2.67	12.73	15.40
1949	0.86	0.47	0.72	0.08	1.76	2.51	2.44	1.18	1.33	4.96	1.57	0.72	4.17	14.43	18.60
1950	0.64	0.20	0.29	1.22	5.15	3.98	5.16	1.38	1.36	1.06	0.79	0.50	5.99	15.74	21.73
1951	0.24	0.48	0.50	1.50	0.35	2.04	1.96	2.80	2.32	1.40	0.59	0.30	3.62	10.86	14.48
1952	0.47	0.18	0.44	0.05	0.47	3.91	3.42	3.00	0.59	0.20	0.12	0.04	1.30	11.59	12.89
1953	0.52	0.38	1.15	0.76	3.75	3.43	3.93	1.34	1.86	1.94	0.08	0.10	3.30	15.94	19.24
1954	0.60	0.26	0.22	1.66	1.34	6.52	1.59	3.07	4.54	0.75	0.55	0.04	3.52	17.62	21.14
1955	1.33	1.19	0.76	0.76	2.54	3.87	2.72	0.71	1.93	0.88	3.54	0.92	7.64	13.51	21.15
Averages—1916 to 1955 (40 years)				1.17	1.87	3.12	2.65	2.06	2.17	1.29					
Averages—1944 to 1955 (12 years)	0.60	0.50	0.92	0.85	1.92	4.04	3.02	2.20	1.94	1.32	0.97	0.51	3.71	15.09	18.80

Monthly Mean Temperatures, Degrees F.

TABLE 6

(Records from the Department of Transport Climatological Stations at Portage la Prairie, Manitoba)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1944	16	4	15	42	58	61	68	65	55	46	28	12
1945	6	9	30	32	44	58	67	66	51	41	18	5
1946	4	2	31	46	51	62	70	64	55	40	22	14
1947	8	1	19	36	48	62	72	69	53	50	22	5
1948	1	4	14	34	55	64	69	68	62	48	28	10
1949	1	−4	19	46	54	64	69	71	54	42	32	4
1950	−12	2	15	31	49	60	66	64	58	45	20	5
1951	−1	8	14	37	57	60	67	62	52	40	20	6
1952	−2	13	17	46	54	63	68	66	58	43	31	21
1953	5	10	21	36	53	63	68	69	54	50	34	16
1954	−10	22	19	32	46	61	69	63	52	43	31	22
1955	1	0	6	46	54	64	71	70	54	41	15	−1
Means, 1916 to 1955 (40 years).	−2	2	16	37	51	62	68	64	55	42	23	8

Outline of Investigations at the Pilot Flax Mill

Work at the Pilot Flax Mill, Portage la Prairie, fell into four main categories, as follows:—

1. *Co-operative Projects with District Farmers:* The object of this phase of the work was to determine, under ordinary farm conditions, the quantity and quality of flax fiber that could be produced in the Portage la Prairie region of Manitoba, the best methods of production, and the costs of production. Another object of these co-operative projects was to secure sufficient fiber flax for mill processing studies.

2. *Experiments in Fiber Flax Production:* Small scale experiments, including variety tests, fertilizer trials, dates of seeding, harvesting methods and weed control studies were conducted on mill property and at various outside points, mostly in southern Manitoba.

3. *Flax Mill Investigations:* The various cost factors involved in processing flax fiber were recorded.

4. *Laboratory Investigations:* These included research on various aspects of fiber processing, water-retting, and uses for the shives produced in flax fiber processing.

Technical services required in connection with the studies were provided in the Mill laboratory.

Co-operative Projects in Flax Fiber Production

During the first three years (1944-46) of the operation of the Pilot Flax Mill, special arrangements were made with farmers in the Portage district to undertake experimental production of fiber and linseed flax under farm conditions. This procedure was necessary because of the uncertainty of yields, and because none of the co-operating growers had had experience in handling this crop. Payment on a per acre basis was made to co-operating farmers to cover the use and preparation of land used for flax production. The actual harvesting, as well as mill processing of the crop, was undertaken by the Pilot Flax Mill. In some cases, especially where farm implements were unsatisfactory for flax, the equipment of

TABLE 7

FROST RECORDS

(RECORDS FROM THE DEPARTMENT OF TRANSPORT CLIMATOLOGICAL STATIONS IN PORTAGE LA PRAIRIE, MAN. IN SOME OF THE EARLY RECORDS TEMPERATURES OF 32.5° F WERE RECORDED AS FROSTS. TEMPERATURES OF 28° F OR LOWER ARE RECORDED AS KILLING FROSTS.)

Year	Last frost in spring		First frost in fall		Number of uninterrupted frost-free days	Last killing frost in spring		First killing frost in fall		Number of uninterrupted days above 28 °F.
	Date	Temp. °F.	Date	Temp. °F.		Date	Temp. °F.	Date	Temp. °F.	
1944	May 7	29	Oct. 1	32	147	May 6	28	Oct. 2	26	149
1945	May 29	27	Sept. 15	32	109	May 29	27	Sept. 28	24	122
1946	May 24	32	Sept. 1	29	100	May 15	26	Oct. 11	26	149
1947	May 29	29	Sept. 22	25	116	May 28	25	Sept. 22	25	117
1948	May 11	31	Oct. 1	32	143	May 10	27	Oct. 16	25	159
1949	May 25	31	Sept. 28	29	126	Apr. 24	21	Oct. 20	20	179
1950	May 16	32	Oct. 3	32	140	May 15	28	Oct. 25	26	163
1951	May 12	31	Sept. 24	28	135	Apr. 24	23	Sept. 24	28	153
1952	May 11	28	Oct. 2	29	144	Apr. 22	26	Oct. 4	26	165
1953	May 15	32	Oct. 6	24	143	May 12	27	Oct. 6	24	146
1954	May 18	31	Oct. 2	30	136	May 7	28	Oct. 4	28	149
1955	May 8	25	Sept. 30	32	145	May 8	25	Oct. 2	27	147
Average (frosts) 1886 to 1955	May 22	(67 years)	Sept. 20	(66 years)	121 (64 years)	—	—	—	—	—
Average (killing frosts) 1944 to 1955 (12 years)	—	—	—	—	—	May 9	—	Oct. 6	—	150
Shortest uninterrupted frost-free period 1926	June 6	32	Sept. 12	32	78	May 28 1947	25	Sept. 22	25	117
Longest uninterrupted frost-free period 1920	May 14	32	Oct. 18	31	157	Apr. 24 1949	21	Oct. 20	20	179

Earliest and latest frost dates, 1886 to 1955.
Latest spring frost—June 26, 1926. 32°F.
Earliest last spring frost—April 22, 1922. 32°F.

Earliest fall frost—August 23, 1934. 32°F.
Latest first fall frost—October 18, 1920. 31°F.

Earliest and latest "killing" frost dates, 1944 to 1955.
Latest spring killing frost—May 29, 1945. 27°F.
Earliest last spring killing frost—April 22, 1952. 26°F.

Earliest fall killing frost—September 22, 1947. 25°F.
Latest first fall killing frost—October 25, 1950. 26°F.

the Pilot Flax Mill was used for seeding and other field operations. In every case emphasis was placed on obtaining good yields, rather than on making uniform comparisons of costs. Seed of good quality was supplied by the Pilot Flax Mill.

From 1947 to 1949, inclusive, the co-operating farmers grew the required acreage of flax as their own crop under the direction of the Pilot Flax Mill staff. Returns from the crop went directly to the farmer who paid the Pilot Flax Mill for work done with their specialized machinery. In 1950 this scheme was replaced by a straight rental proposition and the crop was grown and processed by the Pilot Flax Mill.

The original plan in these experiments was to produce linseed flax in 10-acre fields on each of 10 farms, with a similar acreage of fiber flax for comparison. Variations of this plan were necessary from year to year as shown in Table 8. For example, the entire 100 acres was grown the first year on one farm and the 110 acres on two farms in the second year.

In 1950 the acreage was reduced to 12 acres of linseed and 12 acres of fiber flax and was maintained at that level. Each 12-acre field was divided into three blocks for a comparison of harvesting methods. The treatments used were as follows:—

	Linseed Flax	*Fiber Flax*
Block	1. Pulled for green tow	Cut and water-retted
	2. Cut (grain binder) for green tow	Pulled and dew-retted
	3. Swathed and combined	Pulled and water-retted

The treatment for linseed flax was to compare straw that was pulled with a pulling machine and linseed straw that was cut with a binder and to compare swathed and combined straw with the other two methods. Pulled straw has the advantage of three inches more length in the straw than has binder-cut flax straw. The relative costs of pulling versus cutting favor the cutting method in spite of the extra yield and grade received for the former. The swathed and combined straw produced a short second grade straw for upholstering tow purposes at low cost since it is part of the standard harvesting procedure for large-scale flax harvesting.

The fiber flax treatments were to compare cut straw for water-retting with pulled straw for water-retting as well as pulled straw for dew-retting. Cut and water-retted straw produced a lower yield and grade of fiber than did pulled, water-retted straw. However, the high costs of pulling offset the yield and grade advantage over cut and water-retted fiber.

Flax pulled and spread on the ground for dew-retting is the method used in Ontario and Quebec. The heavy loss of seed and the lack of uniform dew-retting of the straw produce fiber grades of lower value but dew-retted flax is less costly to produce.

It is interesting to note (Table 8) that the average yield over a twelve-year period for fiber flax seed grown on a commercial basis was 7.67 bushels per acre whereas the average yield for linseed flax was 9.68 bushels per acre, a difference of only 2.01 bushels more for linseed flax per acre. The line fiber yields were the highest in 1948 with 311 lb. per acre (No. 3 grade), the tow yield was 333 lb. and 13 lb. of pluckings, or a total fiber yield of 657 lb. per acre.

None of the linseed flax straw produced was suitable for dew-retted, or retted, line fiber and tow production. In four out of the twelve years, the linseed straw was unsuitable even for upholstering tow.

Because of low temperatures, large-scale tank retting and subsequent drying did not prove feasible during the fall and winter seasons at Portage la Prairie, consequently each crop was retted in the following year.

Fiber Flax and Linseed Flax Comparisons

The average yearly profit to those concerned from the fiber crops grown during the first five-year period showed a gradual increase. This was partly due to improved handling methods by the growers and in the Mill, and to a reasonably good market for fiber flax seed. The seed market dropped off sharply during the second five-year period and fiber flax seed had to be sold at linseed prices. While the yield and quality of fiber was improved, marketing was a serious problem.

Combined linseed flax straw made only second grade upholstery tow, because of harsher straw and weak fiber. Moreover, a large percentage of seed ends were left in this fiber even after the straw had been water-retted and scutched. These seed ends were objectionable to the manufacturers and limited the possible markets. The paper trade absorbed a large percentage of the marketed linseed flax straw.

The fiber flax straw made an excellent grade of upholstering tow and was in good demand by the upholstering trade. The lower yield of fiber flax seed offsets this advantage unless it can be sold as *registered* or *certified* seed. It is doubtful if the increased returns received from fiber flax, when harvested by the method commonly used for linseed flax, would offset the difficulty of handling a fiber flax crop with its heavy yield of straw.

Performance of Some Flax Varieties at Portage la Prairie

The primary purpose of this experiment was to determine the fiber production of both fiber and linseed varieties of flax, and the seed yield and quality.

Some averaged yields from this test are given in Table 9. Yields of the linseed varieties were corrected for seasonal effect (all varieties were not under test at the same time).

Among the fiber varieties tested, Cascade has given the best over-all performance. It has yielded consistently well and has been immune to the flax rusts so far encountered at this Station. Some of the other varieties, such as Liral Prince and Stormont Gossamer, yielded better than Cascade in some years, but were very susceptible to rust epidemics. None of the varieties tested has shown much resistance to pasmo infections.

1. The popular Cascade variety of fiber flax in bloom.

TABLE 8

Fiber and Linseed Flax Acreages and Fields in Co-operative Projets 1944-55 (inclusive)

	FIBER FLAX								LINSEED FLAX					
Year	No. acres	No. farms	Variety	Seed bu./A.	Upholstery tow lb./A.	Line fiber lb./A.	Tow lb./A.	Pluckings lb./A.	No. acres	No. farms	Variety	Seed bu./A.	Upholstery tow lb./A.	Grand total acreages
1944..........	110.00	10	Liral Dominion..... Liral Prince........ Stormont Gossamer.	3.90	820	42	238	12	100	1	Royal	4.70	65	210.00
1945.........	149.00	11	Liral Prince........ Liral Dominion.....	7.90	1201	169	256	14	110	2	Royal	11.20	238	259.00
1946..........	91.0	10	Liral Prince........ Liral Dominion.....	5.40	708	135	180	18	35	1	Royal	14.20	Too short and weedy	126.00
1947.........	75.0	7	Liral Dominion......	8.20	748	109.5	381	11	9	1	Royal	9.20	739	84.00
1948..........	112.0	10	Liral Dominion......	7.90	1474	311	333	13	31	2	Royal-Rocket	9.50	690	143.00
1949..........	51.5	6	Stormont Motley....	4.76	1187	—	—	—	31.75	2	Rocket-Dakota	9.50	338	83.25
1950..........	12.0	1	Liral Dominion......	11.00	—	230	211	30	12.00	1	Rocket	21.25	795	24.00
1951..........	16.0	2	Liral Dominion.....	7.92	979	—	—	—	12.00	1	Rocket	6.60	Too short and weedy	28.00
1952..........	12.0	1	Liral Lominion......	7.70	—	97	226	15	12.00	1	Rocket	7.00	Too short and weedy	24.00
1953..........	12.0	1	Cascade............	9.50	—	125	255	10	12.00	1	Rocket	11.00	182	24.00
1954..........	12.0	1	Cascade............	7.50	—	136	230	11	12.00	1	Rocket	4.00	Too short and weedy	24.00
1955..........	12.0	1	Cascade............	10.40	962	—	—	—	12.00	1	Sheyenne	8.10	518	24.00
Total.........	1,201.50		Average............	7.67					673.75		Average.......	9.68		1,875.25

Among the linseed flax varieties the earlier maturing ones have yielded less fiber and oil than the later varieties. The newer varieties, such as Rocket and Redwood, have yielded better than the old standard, Bison, and in addition, were almost completely immune to infection with flax rust at this location.

TABLE 9

AVERAGE YIELDS OF FIBER AND LINSEED VARIETIES OF FLAX

(The numbers in brackets indicate the number of years averaged)

A. Fiber Varieties

Variety	Yield of total fiber (lb./ac.)		Yield of line fiber (lb./ac.)		Yield of cleaned seed (bu./ac.)	
Liral Dominion	508	(7)	199	(6)	10.9	(11)
Liral Prince	585	(7)	264	(6)	8.8	(11)
Liral Duke	292	(3)	126	(2)	10.1	(6)
Stormont Gossamer L26	578	(7)	272	(6)	8.5	(11)
Stormont Motley	609	(3)	311	(3)	8.9	(4)
J.W.S. 153-B-9	560	(7)	222	(6)	14.4	(11)
Toba	512	(5)	168	(4)	11.0	(9)
Cascade	630	(7)	283	(6)	12.9	(8)
Norfolk Queen	760	(2)	320	(2)	9.5	(3)
Rembrandt	621	(2)	180	(2)	14.2	(2)
5-A-3	471	(3)	212	(2)	8.8	(7)

B. Linseed Varieties

Variety	Yield of total fiber (lb./ac.)		Yield of oil (lb./ac.)		Iodine value of oil (Wijs units)*		Yield of cleaned seed (bu./ac.)	
Bison	394	(3)	293	(3)	185	(3)	15.8	(3)
Crystal	390	(7)	440	(9)	194	(9)	17.7	(9)
Dakota	396	(5)	400	(6)	192	(6)	17.2	(6)
Marine	404	(2)	544	(3)	195	(3)	20.1	(3)
Raja	312	(3)	536	(4)	186	(4)	19.6	(4)
Redwing	381	(7)	418	(9)	193	(9)	17.4	(9)
Redwood	454	(4)	573	(5)	194	(5)	20.3	(5)
Rocket	442	(7)	459	(9)	191	(9)	17.9	(9)
Royal	450	(5)	443	(6)	184	(6)	18.2	(6)
Sheyenne	369	(5)	459	(6)	189	(5)	17.4	(6)

* The iodine value of an oil is an indication of its drying quality; the higher the value, the better the quality.

Flax Varieties Tested at the Pilot Flax Mill

Brief descriptions of the more important varieties of flax tested by the Pilot Flax Mill are as follows:

Cascade—A fiber variety recently introduced from Oregon, immune to local rusts.

J.W.S.153-B-9—A selection by the Fiber Division from the variety "J.W.S.". Resistant to some forms of rust, susceptible to wilt, and with little tolerance to pasmo.

Liral Dominion—Fiber variety introduced from Ireland. The term 'Liral' indicates an introduction by the Linen Industry Research Association of Lambeg, Ireland. Somewhat susceptible to rusts, pasmo, and wilt.

Liral Prince—Fiber variety from Ireland. More susceptible to rust than Liral Dominion and also susceptible to pasmo and wilt.

Liral Duke—Irish fiber variety. Susceptible to rusts, pasmo, and wilt. Canadian stocks of seed of this variety have declined in purity in recent years, but steps are being taken to remedy this condition.

Stormont Gossamer L26—A fiber variety developed by the Ministry of Agriculture in Northern Ireland. Susceptible to rusts, pasmo, and wilt.

Stormont Cirrus—Similar to Stormont Gossamer L26.

Toba—A fiber variety developed at the University of Manitoba. Susceptible to pasmo and wilt, but with some resistance to rusts.

5-A-3—A fiber variety, selection by the Fiber Division from Riga Blue. Similar in disease resistance to 153-B-9.

Bison—Linseed variety introduced from North Dakota. Very susceptible to rust, resistant to wilt, and tolerant to pasmo.

Crystal—A linseed variety introduced from Minnesota. Matures a little late. Resistant to rusts.

Dakota—A linseed selection from Bison by the United States Department of Agriculture. Partially immune to American forms of rust, resistant to wilt, and somewhat tolerant to Pasmo.

Marine—Selected by the North Dakota Experiment Station from the cross C.I.975 X Sheyenne. It was licensed for distribution in Canada in 1952. This variety, having early maturity and rust resistance, may replace Sheyenne because of its better yield and larger seed size.

Raja—Selected at the Cereal Division, Central Experimental Farm, from a cross of the Argentine selection Ma X Fb—1025 X J.W.S. 153B9. The line was tested under number 3901D.

Royal—Linseed variety, developed by the University of Saskatchewan. Partly resistant to rusts and somewhat resistant to wilt.

Redwing—Early maturing linseed variety introduced from Minnesota. Similar in disease resistance to Royal.

Rocket—Linseed variety developed at the Central Experimental Farm, Ottawa, from a Redwing and Argentine 8C cross. Resistant to rusts.

Redwood—Selected at the Minnesota Experiment Station from the cross C.I. 980 X Redson, the latter from the cross Redwing X Bison was also made at the Minnesota Experiment Station. Distributed in the spring of 1951. This variety was tested under the number C.I.1130 and licensed in Canada in 1951.

Sheyenne—An early maturing linseed variety licensed in Canada, as an alternative to Redwing in northern districts. Practically immune to rusts, susceptible to pasmo, and somewhat resistant to wilt.

Performance of Some of These Varieties at Other Locations in the Province

A. University of Manitoba Plots:

During the period 1944 to 1954 a flax variety test was conducted on plots at the University of Manitoba under the supervision of the Department of Plant Science at the University. Straw from these tests was shipped to the Pilot Flax Mill for processing. Five to seven different varieties were under test each year

from 1944 to 1951. In 1951 the number of varieties was reduced to three. Although the yields of seed and fiber were a little lower than at Portage la Prairie, the ranking of the varieties was about the same at both localities whether based on fiber or seed yields.

B. Co-operative Extension Flax Plots:

From 1947 to 1952 some small plots of flax were grown on farms in various parts of Manitoba, mostly in the south-central and southeastern part of the province. The work was carried out in co-operation with the provincial Department of Agriculture, Extension Service. Three varieties were sown in these experiments. Two were fiber varieties (L. Dominion and L. Prince) and the third was a linseed variety (Royal in 1947, and Rocket in 1948 and thereafter).

The yields were very variable between locations in any one year, and from year to year at each location. The range of variation was very great. The yields of fiber and seed, however, were often as good as yields obtained from plots at the Pilot Flax Mill, demonstrating that good yields could be obtained under favorable conditions (weather, etc.). Some average yields are given in Table 10 compared with yields obtained in the variety test at the Pilot Flax Mill

TABLE 10

Average Yields of Seed and Fiber from the Co-operative Extension Plots and from the Variety Test over a comparable period. (1948 to 1952).

—	Extension plots	Variety Test at Portage la Prairie
Yield of seed (in bu./ac.)		
L. Dominion	7.4	11.1
L. Prince	5.4	8.2
Rocket	15.4	18.6
Yield of Fiber (in lb./ac.)		
L. Dominion	526	467
L. Prince	540	578
Rocket	473	389

Yields of Fiber Flax Grown Under Irrigation

In co-operation with the Experimental Farm, Lethbridge, a yield test was made of fiber flax grown under irrigation at Lethbridge. The flax was shipped to the Pilot Flax Mill at Portage la Prairie for processing. The varieties Stormont Gossamer L26, Stormont Cirrus, Liral Dominion, and Liral Prince were on test during 1947 to 1950, and Cascade during 1950 only. The yields of fiber and seed from these varieties on irrigated land at Lethbridge were considerably higher than from the same varieties grown at Portage la Prairie. The quality of the fiber was good in three of the four years flax was harvested in this experiment. In 1949, however, although the yields of straw and total fiber were as good as any other year, the yields of line fiber (an index of fiber strength) were very low; about one tenth of the yields obtained in the other years. The yields of seed were also very low in 1949; there is therefore the possibility that the flax may have been harvested before it was properly matured. Some yield data (averages for the four years) from the Lethbridge test and from the variety test grown at Portage la Prairie (long-time averages) are shown in Table 11.

TABLE 11

Yields of fiber flax varieties grown under irrigation at Lethbridge, Alta. (1947 to 1950), compared with long-term average yields at Portage la Prairie

Variety	Yield of seed (bu./ac.)		Yield of total fiber (lb./ac.)		Yield of line fiber (lb./ac.)	
	Lethbridge	Portage la Prairie	Lethbridge	Portage la Prairie	Lethbridge	Portage la Prairie
L. Dominion	14.4	11.1	777	467	370	209
L. Prince	10.1	8.2	861	578	358	278
Stormont Gossamer L26	9.0	9.1	885	548	356	258
Stormont Cirrus	10.0	—	877	—	372	—

Effect of Date of Sowing

This experiment was designed to study the effect of date of sowing on the fiber and seed yields from both fiber and linseed varieties of flax. In 1945 and 1946 the flax was sown at five dates about one week apart, starting in late May and extending into June. From 1947 to 1951 the flax was sown first, weather permitting, at a date that was judged to be about two weeks before wheat should be sown; and at two later dates, each about two weeks apart. In 1952 a fourth date was added. The last sowings were made about the end of the first or second week in June except in 1950, 1953, and 1954 when seeding was delayed by weather conditions till very late. The fiber varieties of flax that were used were early maturing while the linseed varieties used were of the long season type. The results were given in Table 12.

In eight of the ten years, during the period 1946 to 1955, both early and late varieties of flax sown at the later dates yielded less seed than was obtained from the earlier sowings. Yields were generally less when the flax was sown in the second, and in a few cases in the first week of June as compared with that sown in middle or late May.

The yields of fiber were not affected in the same way by sowing date. Fiber yields, from the fiber varieties, were not reduced significantly by planting dates as late as June 18 in five out of seven years from 1947 to 1955. In the two years when such reductions occurred the spring was exceptionally early.

With respect to fiber yields from the linseed varieties (later maturing) as great or significantly greater yields of fiber were obtained from linseed flax sown in early June (as late as June 16), as were obtained from flax sown in May in six out of seven years during the period 1947 to 1954. In only one year was significantly less fiber obtained from flax sown in June (June 10) than from flax sown in May. Yields of deseeded straw were affected in much the same way in both linseed and flax varieties.

Thus, for the later maturing linseed varieties, the best yield of fiber was not always consistent with the best yield of seed. For the earlier maturing fiber varieties the combination of best yields of fiber and seed could be obtained from the earlier sown flax.

TABLE 12

Effect of dates of sowing fiber flax on yields of seed and fiber (1947 to 1955)

Year	First Date		Second Date		Third Date		Fourth Date	
Yield of cleaned seed (bu./ac.)								
1947	May 15	6.3	May 30	8.6	June 15	8.7		
1948	May 21	11.5	June 4	11.4	June 18	8.6		
1949	May 13	12.6	May 27	11.7	June 10	8.8		
1950	June 6	10.6	June 20	8.0	July 6	6.2		
1951	May 8	12.1	May 22	13.8	June 5	13.6		
1952	April 18	17.7	May 9	18.2	May 23	16.2	June 6	14.0
1953	May 21	9.3	June 10	8.8	July 6	0.8	July 20	0.0
1954	May 17	10.0	June 3	10.2	June 16	8.9	July 5	0.0
1955	May 2	12.1	May 17	13.6	May 30	10.0	June 13	6.4
Yield of total fiber (lb./ac.)								
1947	May 15	321	May 30	368	June 15	408		
1948	May 21	510	June 4	616	June 18	557		
1949	May 13	432	May 27	526	June 10	377		
1951	May 8	654	May 22	700	June 5	665		
1952	April 18	624	May 9	637	May 23	547	June 6	520
1953	May 21	457	June 10	573	July 6	303	July 20	183
1954	May 17	914	June 3	803	June 16	956	July 5	751
Yield of line fiber (lb./ac.)								
1947	May 15	75	May 30	70	June 15	86		
1948	May 21	215	June 4	258	June 18	238		
1949	May 13	236	May 27	300	June 10	136		
1951	May 8	303	May 22	277	June 5	88		
1952	April 18	259	May 9	326	May 23	256	June 6	261
1953	May 21	70	June 10	143	July 6	25	July 20	7
1954	May 17	303	June 3	238	June 16	411	July 5	25

Effect of sowing dates of linseed flax on yields of seed and fiber (1946 to 1955)

Year	First Date		Second Date		Third Date		Fourth Date	
Yield of cleaned seed (bu./ac.)								
1946	May 29	6.4	June 5	9.3	June 12	5.5		
1947	May 15	20.3	May 30	17.2	June 15	14.5		
1948	May 21	14.0	June 4	16.9	June 18	6.0		
1949	May 13	20.3	May 27	20.6	June 10	11.7		
1950	June 6	20.8	June 20	17.6	July 6	1.0		
1951	May 8	21.2	May 22	20.6	June 5	22.6		
1952	April 18	31.0	May 9	27.4	May 23	28.9	June 6	27.9
1953	May 21	17.8	June 10	15.2	July 6	0.6	July 20	0.0
1954	May 17	27.2	June 3	27.8	June 16	18.9	July 5	0.0
1955	May 2	17.8	May 17	20.7	May 30	18.6	June 13	13.6
Yield of total fiber (lb./ac.)								
1947	May 15	277	May 30	258	June 15	335		
1948	May 21	293	June 4	550	June 18	386		
1949	May 13	372	May 27	476	June 10	367		
1951	May 8	397	May 22	353	June 5	485		
1952	April 18	487	May 9	510	May 23	536	June 6	596
1953	May 21	483	June 10	566	July 6	453	July 20	249
1954	May 17	482	June 3	653	June 16	762	July 5	637

Effect of the Rate of Sowing Flax

This experiment was designed to study the effect of sowing rates on the yields of fiber and seed, of both fiber and linseed varieties, when grown on naturally weedy soil. The fiber variety was sown at the rates recommended for seed production (1 bu./ac.) and for fiber production ($1\frac{1}{4}$ bu./ac.) and at a considerably

higher rate ($1\frac{3}{4}$ bu./ac.). The linseed varieties were sown at the usually recommended rate ($2\frac{1}{2}$ pecks or 35 lb./ac.), at two higher rates calculated to be equivalent, in seeds sown per unit area, to the 1 and $1\frac{1}{4}$ bu./ac. rates of the fiber flax, and at a rate roughly equal to half the recommended one.

For the fiber variety, which is taller in habit than the linseed varieties sown, the stands (number of plants per yard of row) were thicker by sowing at the higher rates, but yields of fiber and seed were not increased during the six years the variety was under test.

The stands of linseed flax were increased somewhat by doubling the recommended sowing rate but were not reduced by halving it. In spite of this, the yields of seed did not show consistent increases at the higher sowing rates during the eight years this test was carried on. There was, however, a trend to higher yields of fiber at the higher rates in seven of the eight years, with real differences occurring in five of the years.

Sowing rate had more effect on weed infestation in the fiber variety than in the linseed varieties in that there appeared to be fewer broad-leaved and grassy weeds in fiber flax sown at the higher rates. In contrast with this, sowing linseed flax at the higher rates did not appear to have any effect on the infestation with broad-leaved weeds, although the higher rates appeared to reduce the numbers of the grassy types. (These conclusions are based on weed counts carried out in two years during the seven years' testing.)

Effect of Herbicides on Quality and Yield of Flax Fiber

To determine the value of weed control with herbicides in fiber flax several tests were made to study the effects of these compounds on the yield and quality of flax fiber.

2,4-D and MCPA

Since 1948, experiments have been carried out to determine the effects on flax of treatment with two systemic herbicides, 2,4-D (2,4-dichlorophenoxyacetic acid) and MCPA (2-methyl, 4-chlorophenoxyacetic acid). The experiments included tests of various formulations, rates of application, and treatment at different growth stages of the flax. The results obtained may be summarized as follows.

2,4-D versus MCPA

In one test 2,4-D amine and ester, and MCP salt, amine and ester formulations were compared for their effects on fiber flax. Results from six years of testing showed that fiber flax was more sensitive to the action of 2,4-D, and especially the ester form, than to the action of MCPA. For example, an 8-ounce (acid equivalent) per acre application of 2,4-D ester and a 12-ounce per acre application of 2,4-D amine caused as much or more damage to flax fiber and seed yields as did applications of 16 ounces per acre of the MCPA formulations (salt, amine, and ester).

Effect on the fiber

The yield and the quality of the fiber, as evidenced by the yield and quality of line fiber, were quite often found to be more sensitive to the action of the systemic herbicides than were the seed yields. In 5 out of 17 tests treatment with 8 oz. of 2,4-D amine per acre reduced total fiber yields without affecting seed yields. It is possible that these reductions in fiber yield were caused, at least in part, by reduction of the vigor of growth of the flax stem, because the fiber yields were paralleled to a certain extent by the straw yields.

Yields of line fiber were reduced in 12 of 17 tests by treatments with 4 to 8 oz. of 2,4-D amine, 4 oz. of 2,4-D ester, or 8 oz. per acre of MCP (ester, amine and sodium salt). The quality, and in some cases the length, of the line fiber was also affected. Some samples of line fiber from one of the rates tests (2,4-D amine applied at 0, 2, 4, and 8 oz. acid equivalent per acre) were tested for ultimate fiber cell tensile strength. The fiber from the treated flax was found to be weaker than that from the untreated flax.

Stage of growth at time of treatment

In an experiment, which was carried on for three years, a fiber flax (L. Dominion) and a linseed flax (Rocket) were treated, at six growth stages; from the 4 to 5 true leaf stage to the stage when the bolls were fully formed but not yet ripening. A comparatively heavy dose (8 oz. acid equivalent) of 2,4-D amine was used so as to obtain some damage even at some of the less susceptible stages. The results indicated that the growth stage at which flax enters a period of increased sensitivity to the damaging action of 2,4-D was about the same for fiber production as for seed production. The beginning of this period appears to be at the time buds are forming on the plants. The results of determinations of oil content of the seed and iodine number of the oil in 1952 and 1953 showed that treatment with 2,4-D at a susceptible stage may have some effect on seed quality.

TABLE 13

Yield of flax following treatment at various stages with 8 oz. acid equivalent of 2, 4-D amine per acre—1951 to 1953.

Year	Untreated check	Stages					
		1	2	3	4	5	6
		Seed Yield (bu./ac.)					
Liral Dominion							
1951	11.0	12.9	12.9	11.3	15.1	9.7	11.3
1952	19.0	19.5	17.1	*	9.1	*	11.6
1953	9.8	7.0	7.7	*	2.9	3.8	8.0
		Total fiber (lb./ac.)					
1951	632	557	512	381	600	646	568
1952	818	794	818	*	702	*	727
1953	710	608	593	*	767	770	694
		Seed yield (bu./ac.)					
Rocket							
1951	21.8	22.2	20.0	19.3	20.9	20.6	20.0
1952	30.2	32.4	28.8	*	18.0	*	20.3
1953	21.1	17.1	13.2	*	9.8	11.8	17.4
		Oil content of seed (%)					
1951	43.32	43.83	43.44	42.59	42.71	42.97	43.71
1952	42.82	43.04	43.81	*	41.56	*	39.68
1953	40.94	40.83	40.28	*	39.73	40.15	38.55
		Oil Iodine Number (Wijs units)					
1951	196	196	196	195	195	195	196
1952	194	194	192	*	184	*	190
1953	182	183	183	*	188	185	178
		Total fiber (lb./ac.)					
1951	462	441	459	381	455	452	427
1952	607	600	730	*	656	*	617
1953	721	694	659	*	734	699	763

[1] *Stages*

1—4 to 5 true leaves (3 to 5 inch stage in 1953)
2—5 to 7 inches tall (6 to 8 inch stage in 1953)
3—prebud to early bud
4—late bud
5—new full flowering
6—bolls formed, not ripened.

* Weather conditions prevented treatment of the flax at stages indicated.

TCA (Trichloracetic acid)

A test was conducted for two years to determine the residual effects of pre-emergence treatment on fiber flax with TCA. In these tests TCA was applied to the soil immediately after sowing. It was found that both fiber and seed yields were affected even by low rates of application. There was a substantial reduction in line fiber yield from fiber flax treated with as little as 5 pounds acid equivalent of TCA per acre. The quality of the fiber was also lowered by this treatment. The stand and vigor of the flax plants were also quite obviously affected.

Following this a test was started to determine the effects of post-emergence treatment of fiber flax with TCA alone and in combination with 2,4-D. The stage of growth of the flax at the time of treatment ranged from 3 to 5 inches tall in 1952, to 7 to 9 inches tall in 1954. The treatments were 0, 5, and 10 pounds acid equivalent of TCA per acre alone and in combination with 3 ounces acid equivalent of 2,4-D amine per acre. The results from the four years this test was carried out (1952 to 1955) indicate that some reduction in yield of seed and fiber may result if the flax is treated with as little as 5 pounds acid equivalent of TCA per acre. There was no evidence that the effect of TCA was increased or diminished when used in combination with 2,4-D (i.e. a single treatment containing both herbicides).

TABLE 14

AVERAGE YIELDS OF FIBER FLAX TREATED WITH TCA, 1952 TO 1955.
(EACH TCA MEAN IS THE AVERAGE OF TREATMENT BOTH WITH AND WITHOUT 2,4-D)

Rate of application of TCA. lb. acid/ac.	Yield of seed (bu./ac.)	Yield of total fiber (lb./ac.)*	Yield of line fiber (lb./ac.)*
0 lb.	12.5	695	273
5 lb.	11.2	658	238
10 lb.	9.8	626	216
Means of treatments:			
Without 2, 4-D	11.0	662	244
With 2, 4-D	11.3	657	239

* For the period 1952 to 1954 only.

Effect of Stage of Maturity at Harvest

The object of this experiment was to determine the best stage of maturity at which to harvest flax by pulling to obtain the best fiber yield, consistent with good seed yield. The stages of maturity at which the flax was harvested (weather permitting) were:

1. When the seed bolls were formed but still green.
2. When about 50 per cent of the bolls were ripened, the straw was a golden color and part of the leaves had fallen.
3. When the bolls were all or nearly all ripe, the leaves had all fallen, and the straw was fully ripe.

In all cases the flax was pulled and left in the field till cured.

In the light of the results, the best time to harvest flax, in order to obtain best yields of fiber without sacrificing seed yield, is when a large proportion of the seed bolls are ripe. This occurs when the flax is approaching complete maturity. In two of the three years that it was possible to harvest a fiber variety when none or only a few bolls were ripening, the flax pulled at that stage gave a lower yield of fiber than the flax pulled later. In two of the three years

that fiber yields were obtained from a linseed flax, the trend was the same. There was no consistent pattern in fiber quality, favoring one or another harvesting date, for either the fiber or linseed variety.

In five out of six cases the flax harvested at the first stage of maturity mentioned above, gave lower seed yields than flax pulled later. In five of six cases in which the flax was harvested when 10 per cent or more of the bolls were ripe, there was no relation between seed yield and stage of maturity at harvest. In several cases it was noted that flax harvested when 100 per cent mature tended to have lowered seed yield, probably due to shattering during handling. When the flax was harvested before any bolls ripened, the immaturity of the seed was usually reflected in a lower oil content with a slightly higher iodine number.

Rotations and Crop Sequence

In 1950 tests were commenced to compare yields in the following six rotations:

1.—Fallow—flax—wheat

2.—Fallow—wheat—flax

3.—Sugar beets—flax—wheat

4.—Fallow—oats—wheat—flax

5.—Fallow—wheat seeded down—grass and alfalfa—plowed early June and fallow—flax—wheat

6.—Fallow—wheat seeded down—grass and alfalfa—plowed early June and fallow—wheat—flax

The rotations were designed to make comparisons between (*a*) a three-year rotation including summerfallow, a grain crop, and flax, (*b*) a similar three-year rotation in which sugar beets were substituted for the summerfallow, (*c*) a four-year rotation including summerfallow, two grain crops and flax, and (*d*) a six-year rotation which included summerfallow, grain, hay, and flax. It will be noted also that a comparison was made between growing flax after fallow and after wheat in the three- and six-year rotations. In this experiment one plot was provided for each year of each rotation. In this way, once the correct sequences and rotations became established, results were obtained every year.

The following tentative conclusions were drawn from the experiment:

(*a*) Flax yielded about the same amounts of seed and fiber when grown after wheat or summerfallow, but more seed and less fiber when sown after sugar beets.

TABLE 15

YIELD OF FLAX FOLLOWING SUMMERFALLOW, WHEAT, AND SUGAR BEETS, 1951 TO 1955. (AVERAGES OVER ALL ROTATIONS).

Crop sequence	Yield per acre	
	Seed (bu.)	Total fiber (lb.)
Flax after:—Fallow	10.6	632
Wheat	10.7	600
Sugar Beets	11.5	526

(*b*) Among the three-year rotations, for which there are four years' results from plots that have undergone the complete rotations, number three gave the best flax seed yields but the poorest fiber yields.

TABLE 16

YIELD OF FLAX IN THE THREE-YEAR ROTATIONS, 1952 TO 1955

Rotation No.	Yield per acre	
	Seed (bu.)	Total fiber (lb.)
1	9.8	549
2	9.9	570
3	11.1	499

(*c*) Wheat yielded about as well when sown as second crop after flax (34.1 bu./ac.) as when sown after summerfallow (35.5 bu./ac.)

Effect of Application of Commercial Fertilizer

A test was made on the effects of low rates of application of commercial fertilizer to flax (in a three-year rotation of fallow—flax—wheat) grown on a very fertile, black loam soil at this station. Applications of 50 lb. per acre of 11-48-0 and 60 lb. per acre of 16-20-0 gave negative results in all of the six years the test was carried on. This period included seasons with both good and poor moisture supply.

Effect of Cultural Practices on Chlorosis in Flax

In the Portage Plains, flax fields often show abnormal yellowing in the early stages of growth. It was noticed that this chlorotic condition appeared in flax fields most conspicuously where tractor wheels had packed the soil, either before or during sowing. An effort was therefore made to produce chlorotic flax by packing the soil in varying degrees of firmness. The cultural treatments included surface raking, packing twice or four times with a cultipacker and packing once with tractor wheels both before (1948 to 1950) and after (1951) sowing. Before any treatments were carried out, all but the raked plots were given the cultural treatments usually given to flax plots before sowing (i.e. cultivated, harrowed, and packed once with a cultipacker). In the four years during which the test was carried on (1948 to 1951) no relation was found to exist between presence or extent of chlorosis and any of the cultural treatments practised. Seed and fiber yields were not affected in any year by any of the treatments.

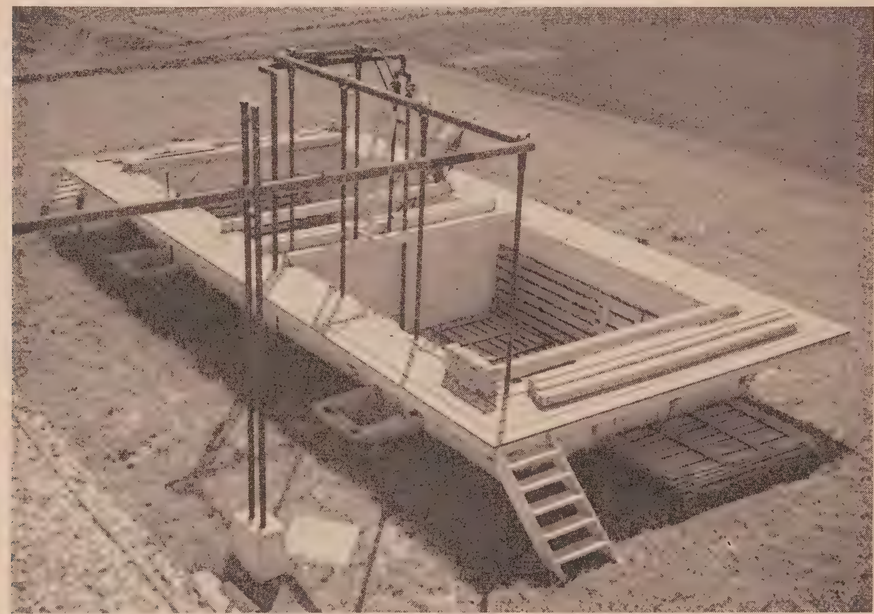
Co-operative Flax Variety Tests

Three co-operative tests have been conducted at the Flax Mill. The "National Flax Test", an adaptation test of promising new linseed flax varieties, was carried on in co-operation with the Cereal Breeding Laboratory at Winnipeg. An adaptation test of fiber varieties of flax was conducted for the Cereal Division at Ottawa, and a test of "Commercial Fiber Flax Varieties" was carried for the Fiber Division at Ottawa. Seed for this type of test is supplied by the co-operating agency and the harvested flax is returned to them for processing.

Studies in Water-Retting

Water from the Assiniboine River is quite alkaline and carries some 400 parts per million of total hardness. However, no trouble was experienced in securing effective rets with this water, provided satisfactory temperatures were maintained. On the basis of five years' work, it may be tentatively concluded that retting at high temperatures (91 to 95 degrees F.) can be completed more

rapidly than at lower temperatures and with no ill effect on fiber grade. Retting at 95 degrees is more costly in fuel and in labor, (requiring night attendance), than retting at 76 degrees. A final cold rinse of the retted straw serves to cleanse the material of organic acids that developed during retting and greatly reduces the dust produced during subsequent processing. Retting the straw for one and a half times as long as was usually considered necessary for proper retting appeared to have no effect on quantity or quality of fiber in these particular experiments. This is contrary to experience at other localities where water retting is used. Possibly the particular bacteria which carry out the retting action in this locality may be the cause of these rather unusual results. Water : straw ratios ranging from 1:12 to 1:42 seemed equally satisfactory.



2. Experimental water-retting tanks at the Pilot Flax Mill.

3. Pulling and spreading fiber flax for dew-retting.

Attempts at devising a practical test to indicate the completion of the retting process other than by expert examination were unsuccessful. It was found that the change in the oxidation-reduction potential and acidity of the retting water (as measured on the pH scale) were of no use to indicate the end of a ret. However, these tests did indicate the commencement of retting action.

Laboratory Studies

Routine analytical services in connection with flax processing and field plot experiments were provided in the laboratory of the Pilot Flax Mill. In addition research was conducted in connection with improvements in the technique of flax processing, and the industrial utilization of flax by-products. The following notes will indicate the nature of this work and the results secured.

Efforts to devise chemical and physical tests for flax fiber quality have so far proved unsuccessful. Chemical analyses reveal no significant relationship between fiber quality and the quantity of cellulose, lignin, ash, and the ether-alcohol and chloroform-soluble constituents of fiber. Physical tests of fiber strength were carried out with the Pressley Fiber Strength Tester and the results were examined statistically. Because of the inadequate method of gripping the flax fiber for strength tests, no conclusions could be drawn from the tests made with this machine.

Various methods of chemical retting, that is the bringing into solution or the effecting of hydrolysis of cementing substances (pectins and gums) which are present in the flax plant, were tested in the Pilot Flax Mill Laboratory. Fiber of fair quality was produced by treatment with 0.5 per cent ammonium oxalate and with 1.25 per cent ammonium hydroxide. The fiber so produced, however, was not so soft and pliable as that from water-retted and dew-retted flax.

During bacteriological retting the cementing substances (pectic material mostly, and gums) are hydrolized by enzymes secreted by the microbes. Of all the constituents of the straw, the pectins are the most extensively attacked during retting. For this reason the pectic enzyme complex present in retting was studied. Results obtained indicate that optimum pectinase activity (as judged by increase in reducing groups) was at a pH of 5.5 at 35°C. Activity in rets carried out at 35°C was detectable after 24 hours and usually reached a maximum in 48 hours to 72 hours from the start of the ret.

Utilization of flax shives

Shives constitute about 75 per cent of the original flax straw entering into the processing of retted flax and paper tow, and about 50 per cent in the case of upholstering tow. Since appreciable quantities of this material accumulate at fiber mills, its utilization economically would be advantageous.

Shives as livestock litter: Shives have entered into commerce to a limited extent as livestock litter. Several mills in Eastern Canada have in the past baled and marketed shives for use as poultry litter in the southern United States, at good prices. Farmers using shives as litter in the Portage la Prairie district report that this material is superior in absorptive capacity to wheat and oat straw.

Shives as fuel: Loose shives have been used as a partial source of heat in the operation of fiber flax mills and other buildings. However, high ash content and bulkiness are major objections to the use of shives as fuel. The possibility of compressing shives into billets or briquettes has received attention at the Pilot Flax Mill. Experiments conducted so far show that air-dry shives when

subjected to pressure and heat, and partially cooled in the press, form dense, compact briquettes; but that when the pressure is released at above the temperature of boiling water, the briquettes split because of gas formation. Some experimental fuel logs were formed in a machine used commercially to form fuel logs from sawdust and other such wastes. Firm and dense logs could be formed with fiber-free shive, but this machine could not handle shive with any fiber in it. The fuel logs made compared favorably on burning with logs made commercially from sawdust and from sunflower seed hulls. Analyses made at the Pilot Flax Mill showed that the ash content of flax shives ranged from 1.0 to 14.3 per cent, as compared with 0.4 per cent for a sample of wood waste, 3.5 per cent for Drumheller coal, and 7.5 per cent for Souris coal. The heat content of one sample of pressed shives was 7,554 B.t.u. per pound, as compared with about 8,500 B.t.u. for wood refuse.

Shives in the manufacture of wall board: The experimental manufacture in the Pilot Flax Mill of insulating board from shives without additives has resulted in the production of material which, while possessing tensile strength, rigidity and workability, was about three times as heavy as some commercial wall boards. Temperatures used in these experiments ranged from 110°C (230°F) to 200°C (392°F) and pressures from 250 to 5,000 pounds per square inch. The most satisfactory boards were produced with a pressure of 5,000 pounds per square inch and a temperature of 140°C (284°F). A less compact board was produced by pressing at 250 pounds per square inch after digesting in an autoclave for an hour with either water or dilute sodium hydroxide. The resulting board, however, was still too dense to have any value as an insulating board. Some experiments have also been made on the use of ground shives mixed with water-proofing materials, for making a panelling board type material. The results from a considerable number of such experiments indicate that flax shives do not constitute a very suitable raw material for such a type of board.

Flax Breaker Baler for Field Use

The manufacturers of cigarette and other fine papers require a large tonnage of combined or threshed flax straw as raw material for their products. The usual procedure is to have the flax straw baled and shipped to a decorticating plant where the straw is partially processed before shipment to the pulping mills. The decorticating plant reduces the straw to about 40 per cent of its original weight, the remainder being waste material of no value to the paper manufacturer. The cost of baling and shipping this large percentage of waste material has been of some concern to the paper companies who felt that a good part of the scutching could be done in the field, thereby reducing the handling and shipping costs and leaving the waste material on the field to be worked into the soil.

With this problem in mind, a machine was built in the winter of 1950-51 by the Flax Mill staff using a No. 43 Heavy Duty Flax Brake, the pick-up from a Flax Lifter, and an International U2 gasoline engine. These parts were mounted on a wooden frame with large steel wheels from a discarded threshing machine. An automatic baler was trailed behind the breaker.

The No. 43 Flax Brake with open-fluted cast rollers proved unsatisfactory because the construction of the flutes was such that they were too open to give sufficient breaking action. In addition the rolls would not stand up under the speed and pressure required to handle the volume of straw fed to the machine.

The engineering staff of the Dominion Experimental Station, Swift Current, was consulted in 1951 for the purpose of remodelling the machine to use rolls from the No. 34 Donkey Brake. These are closely meshed cut steel rolls that will stand great pressure and speed. Four pairs of rolls and the necessary bearings and end plates were built into the machine in place of the No. 43 Flax Brake. Provision was made whereby the speed of each pair of rolls could be changed if this proved necessary. It was considered that by running each pair slightly faster than the preceding pair a straightening action would take place thus improving the efficiency and capacity of the machine.

Test runs with the open-fluted rollers reduced the weight of the straw by 12 to 15 per cent while the steel rollers reduced the weight by 30 to 40 per cent with a capacity of 1,000 lb. straw per hour for either machine. The roller speeds in the rebuilt machine were 310, 338, 369, and 402 r.p.m.

While the breaking action on the second machine was fairly good, some of the straws passed through crossways and were unbroken, giving an uneven product. The capacity was considered low for a practical field breaker. Bunches of straw in the field also proved to be a source of trouble.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
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